

Welcome to NASA Applied Remote Sensing Training (ARSET) Webinar Series

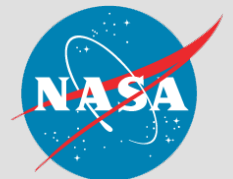
Flood Monitoring using NASA Remote Sensing Data

Course Dates: November 19, 26 December 3, 10
Time: 8-9 a.m. Eastern U.S. Time (13-14 p.m. UTC)



ARSET

Applied Remote Sensing Training
A project of NASA Applied Sciences



<http://water.gsfc.nasa.gov/>

Modules in English
and Spanish

Case
Studies

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Water Resource Management

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ARSET: Air Quality

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Project Description

The goal of this NASA Applied Remote Sensing Education and Training project is to increase the utility of NASA Earth Science and model data for decision-makers and applied science professionals in the area of Water Resources Management Applications. The project conducts trainings and other capacity building activities on utilization of NASA satellite remote sensing and model data for a variety of water management applications including floods and snow related topics. Training activities are a combination of lectures and hands-on activities that teach professionals how to access, interpret, and apply NASA rainfall, snow, cloud, and atmospheric humidity products at regional and global scales with an emphasis of Case Studies. This website provides access to educational materials and regular updates on upcoming events and workshops.

If you would like more information about any of the activities and materials available on this site or to request a training please contact: Ana.I.Prados@nasa.gov

Scheduled Trainings

Webinar: NASA Remote Sensing Data for Water Resources Management

October 17 - November 14, 2013
Thursdays at 1 pm EDT (5 pm UTC)

For further Information
contact: amita.v.mehta@nasa.gov

Course is free but you must register [here](#)

[Webinar Agenda](#) - pdf, 111.69 kB:

Stay Informed

If you would like to be informed of upcoming workshops and project activities please sign up for [List Serv](#).

Certificates of Completion (upon request):

You must attend all 4 live sessions

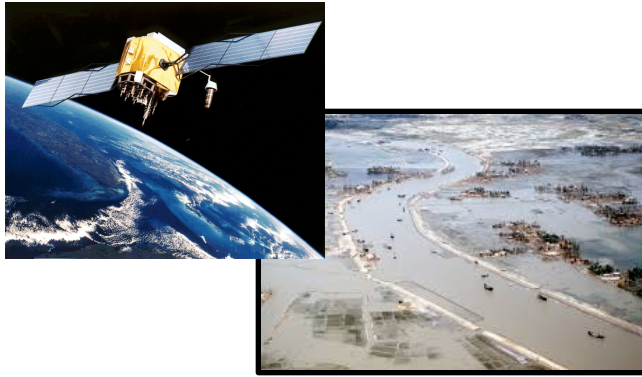
You must submit the homework assignments

For Webinar Recording Link :

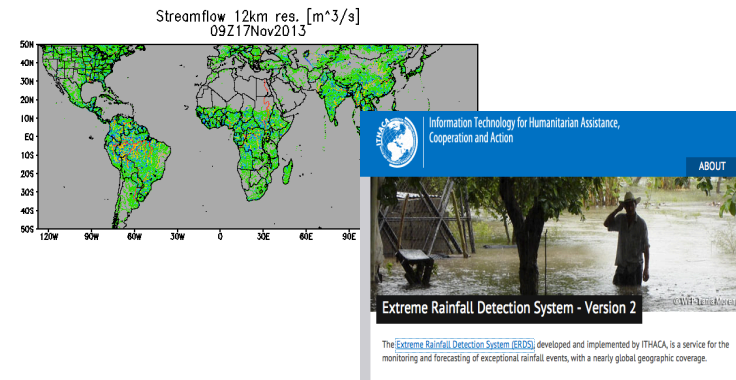
Contact : Marines Martins

Email: marines.martins@ssaihq.com

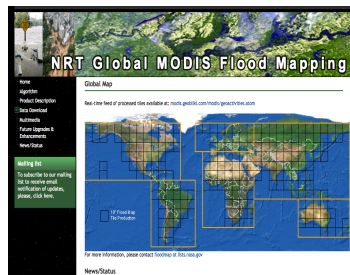
Course Outline



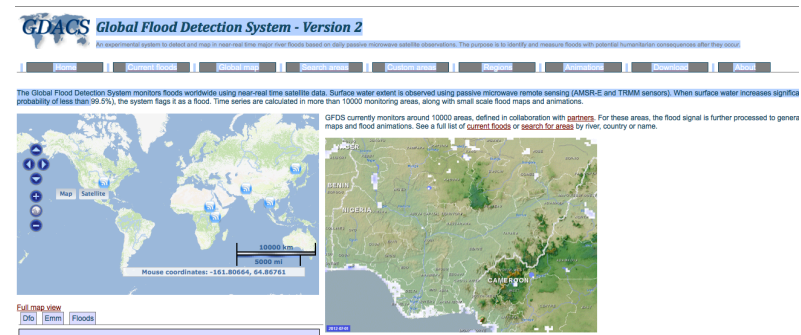
Week 1: Overview of Remote Sensing and Flooding Tools



Week 2: TRMM-based Tools - Extreme Rainfall Detection System and Global Flood Monitoring System



Week 3: MODIS-based Tools – MODIS Inundation and Dartmouth Flood Observatory



Week-4: Global Flood Detection System, multi-satellite flooding case studies with GIS

Outline for Week-3

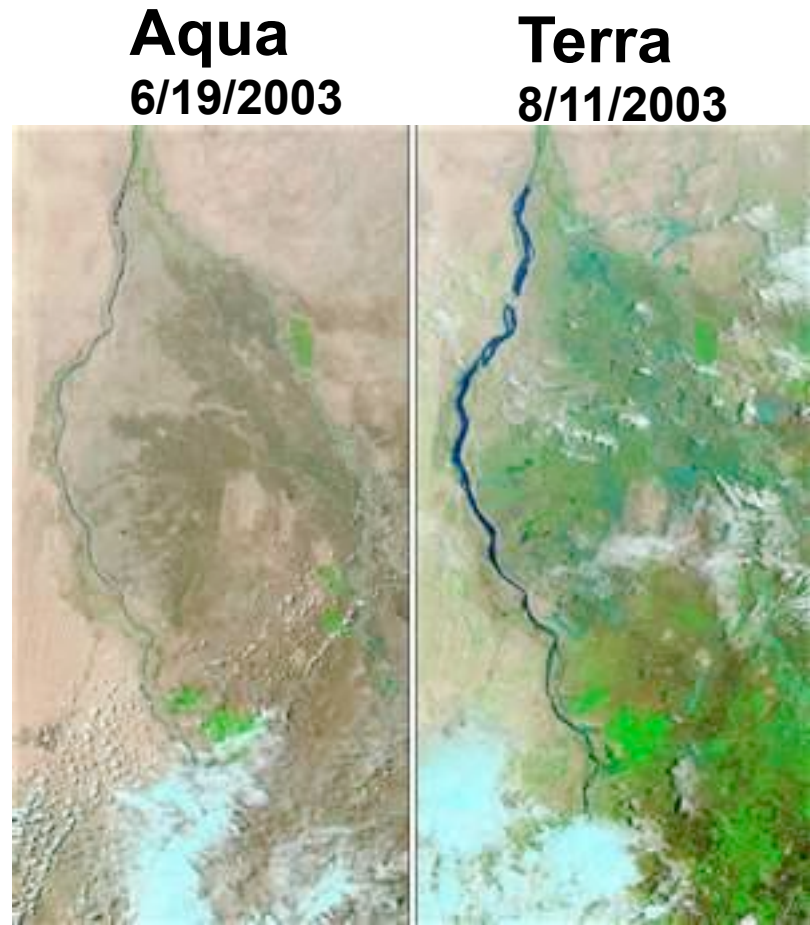
- **Review of MODIS**
- **Review of various flood tools: how the TRMM-based flooding tools differ from the MODIS-based tools?**
- **Overview and Demonstration of:**
 - Global MODIS Inundation Mapping Tool
 - Dartmouth Flood Observatory (DFO)
- **GIS Accessibility of MODIS Inundation Mapping Tool**

Review from Week-1 about MODIS

MODerate Resolution Imaging Spectroradiometer (MODIS)

<http://modis.gsfc.nasa.gov>

- Flying on-board Terra and Aqua – polar orbiting satellites
- Global measurements, 2 times per day
- 36 spectral bands observing atmosphere, ocean, and land properties
- Measurement footprints vary from **250 m to ~1 km**



Flooding along the White **Nile**, Sudan
From : Natural Hazards
earthobservatory.nasa.gov

MODIS Data for Inundation Mapping

MODIS Data:

Reflectance in Optical Bands 1, 2, and 7

Spatial Resolution:	250m x 250m
Spatial Coverage:	Global
Temporal Resolution:	Daily, 8-day, 16-day
Temporal Coverage:	1998 to present

Note: MODIS also provides observations of snow cover, vegetation indices

Strength: High Resolution, Globally Consistent

Limitation: Data can not be retrieved when clouds are present

Interactive Flood Tools

- **NASA-TRMM Current Heavy Rain, Flood, and Landslide Estimates**
- **Global Flood Monitoring System (GFMS)**
- **Extreme Rainfall Detection System (ERDS)**
- **Global MODIS Inundation Mapping**
- **Dartmouth Flood Observatory (DFO)**
- Global Disaster Alert and Coordination System (GDACS)/
Global Flood Detection System (GFDS)

All the tools include Interactive Maps and Regional Sub-setting and zooming capability of flooding events

There is a conceptual difference between the TRMM-based and MODIS-based flooding tools:

TRMM provides direct observation of surface rainfall. The rainfall data are either directly used for inferring to flooding or are used in conjunction with hydrology model to derive streamflow or runoff.

MODIS provides observations of land-surface. MODIS reflectance from various bands indicate presence of water on land surface.

Flood Tools Using TRMM and Hydrologic Models

Flood Tool	Satellite/ Instrument Or Model	Quantities Used as Inputs	Hydrological Model
NASA- TRMM	TRMM/ TMPA-RT	Rain Rate	NRC-CN ¹
ERDS	TRMM/ TMPA-RT	Rain rate	-----
GFMS	TRMM/ TMPA-RT	Rain Rate	VIC- UMD DRTR ²
	MERRA	Surface Temperature Winds	

¹Natural Resources Conservation Service (NRCS) runoff curve number (CN) method

²The University of Washington Variable Infiltration Capacity (VIC) land surface model coupled with the University of Maryland Dominant River Tracing Routing (DRTR) model

MODIS-based Flood Tools

Flood Tool	Satellite/ (Instrument	Quantity Used
MODIS NRT	Terra and Aqua/ MODIS	Reflectance Bands 1, 2, 7
DFO	Terra and Aqua / MODIS	Reflectance Bands 1, 2, 7

Information Provided by the Flood Tools

Flooding Monitoring Output

Flood Tool	Rainfall (Used as Input)	Flood potential/ Intensity	River Discharge/ Streamflow	Inundation Map
NASA- TRMM	X	X		
GFMS	X	X	X	
MODIS/NRT				X
DFO			X (Experimental limited number of river basins)	X

- MODIS provides surface inundation only, can not view the surface in the presence of clouds, mountain and cloud shadows may get interpreted as water
- TRMM Rain, used as along with hydrologic model and other weather and surface data provide quantitative river streamflow and runoff information but rl calibration and validation are recommended with regional stream gauge data

More About the Flood Tools

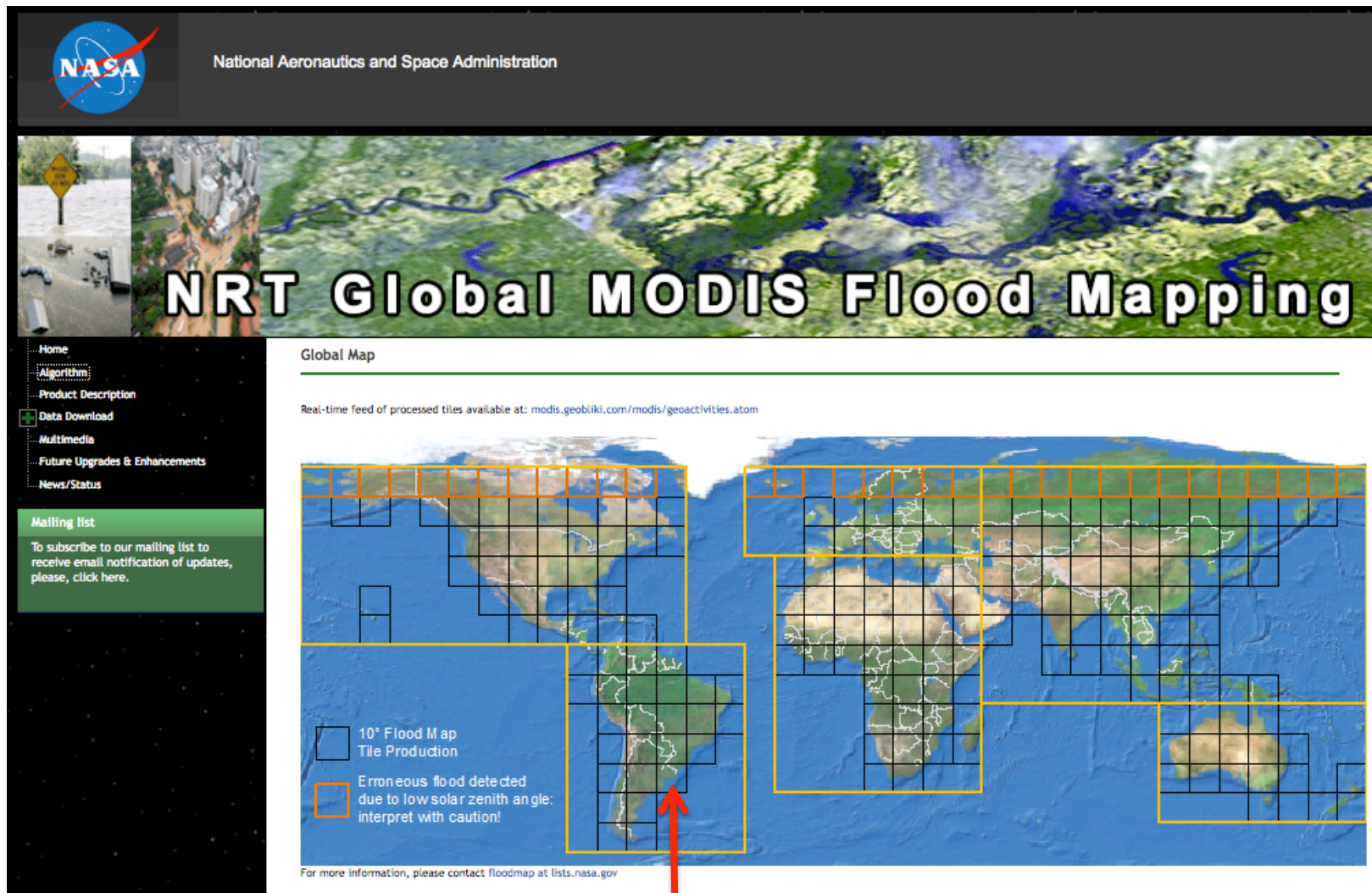
Flood Monitoring Tool	Spatial Coverage and Resolution	Comment
NASA-TRMM NRT	50°S-50°N 12 Km	Includes GFMS, Landslide Potential
GFMS	50°S-50°N 12 Km	Will be available at 1Km resolution. Predictive capability will be added soon
MODIS NRT	Global 250 M	May not be effective in presence of clouds
DFO Experimental	Global 250 m and 10 km	Same as MODIS NRT. River discharge data derived from TMI and AMSR/AMSR2*

* AMSR : Advanced Microwave Scanning Radiometer flying on Aqua satellite (2002-2011) and AMSR2 is flying on Global Change Observation Mission (GCOM-W) satellite (May 2012 to present)

Inundation Mapping Tools based on MODIS

MODIS Inundation Mapping

<http://oas.gsfc.nasa.gov/floodmap/>



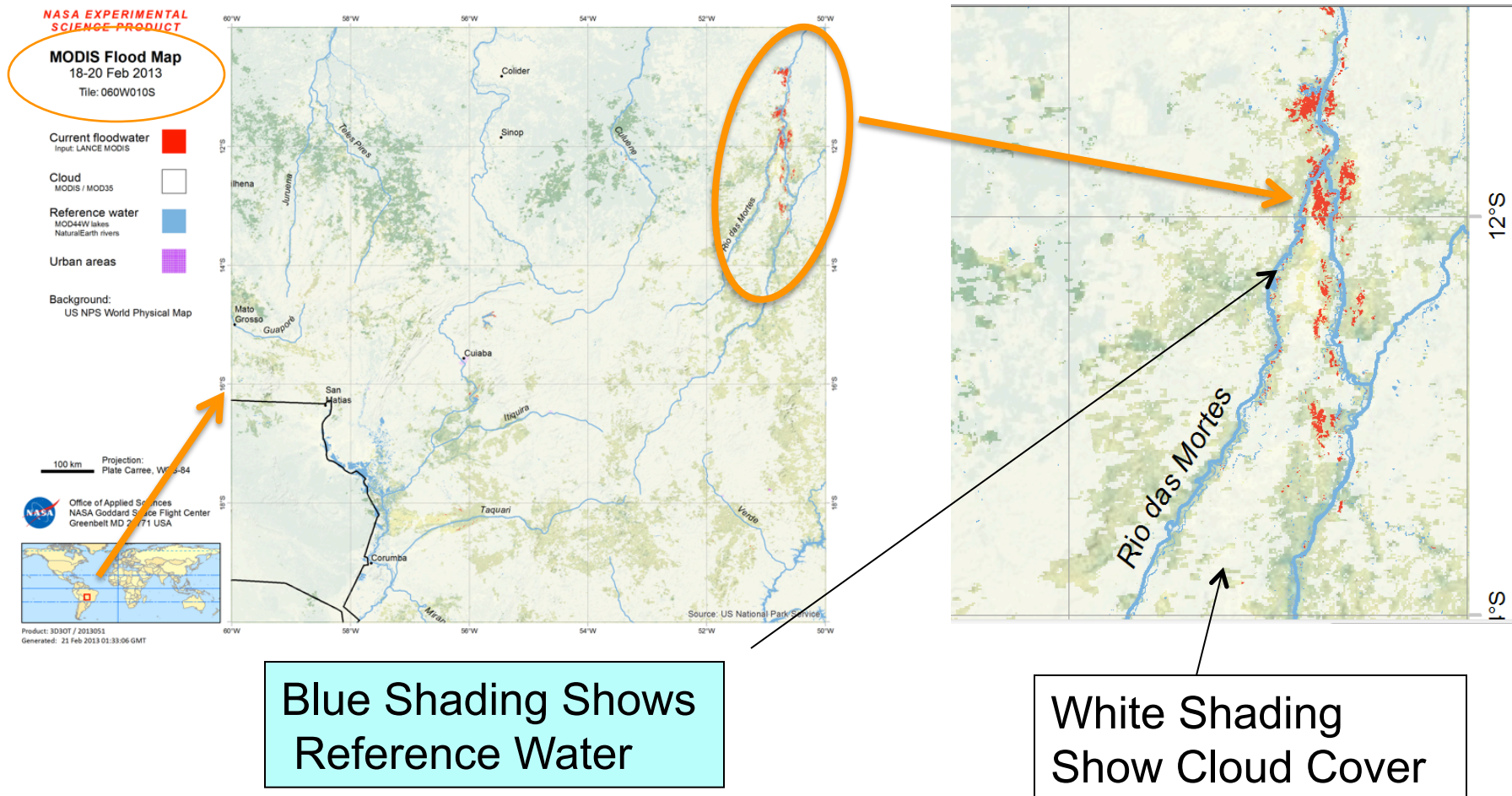
MODIS Inundation Mapping: Zoom on a region

<http://oas.gsfc.nasa.gov/floodmap/>

Red Shading Shows Inundated Surface

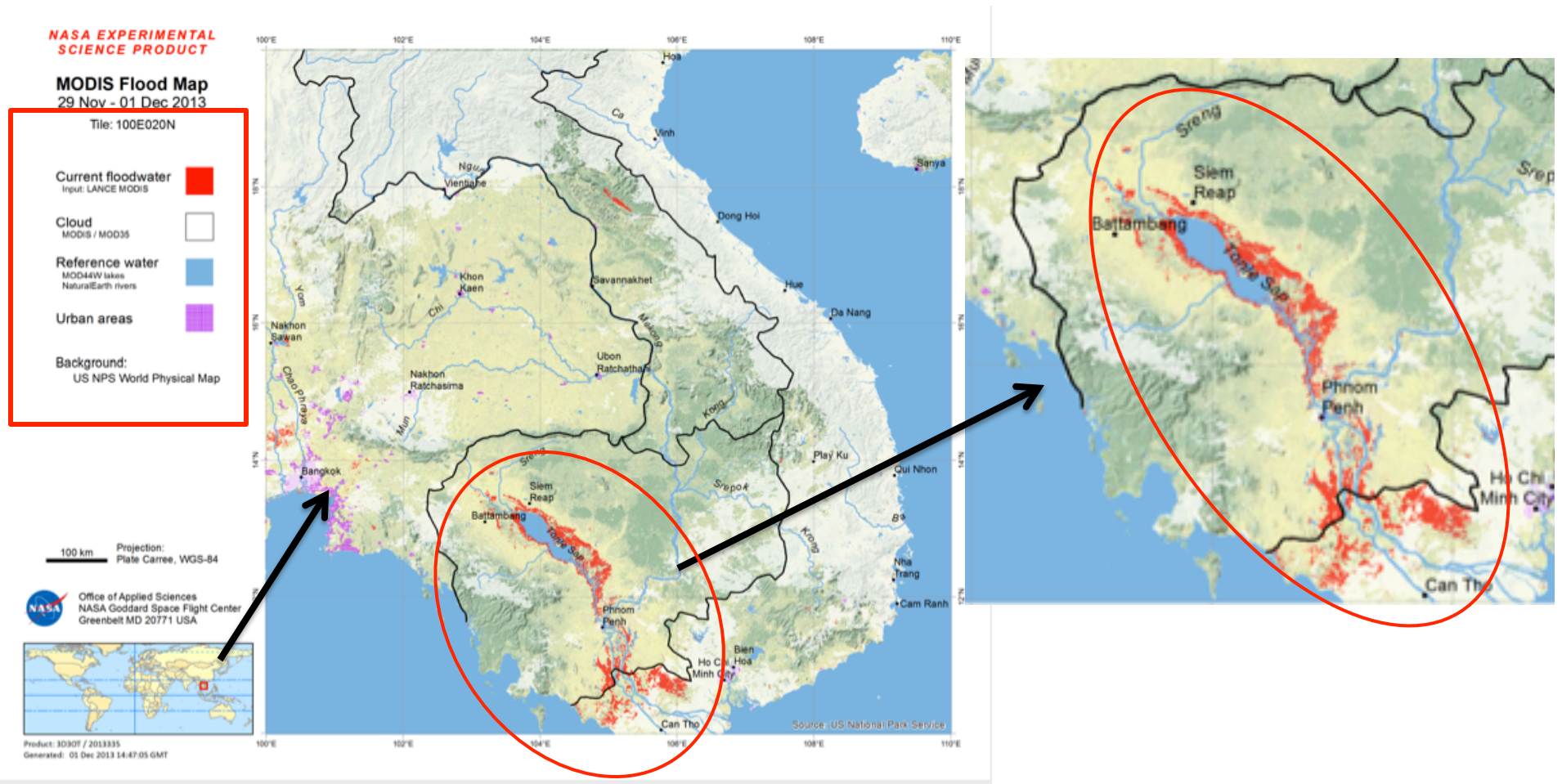
Regional Mapping

Pixel size 250 m



MODIS Inundation Mapping

Flooding over Cambodia 29 November-1 December



MODIS Inundation Mapping

PRODUCTS:

MFV: MODIS Flood Map = annotated 10x10 degree map/graphic product (currently available in png format).


MSW: MODIS Surface Water (Pixel classified with presence of water = **Reference Water** + Flood Water). This is based on a ratio of MODIS bands 1, 2, and 7 reflectance values.

Reference Water: based on MODIS reflectance and Shuttle Radar Topography Mission Water Body Data.




MFV: MODIS Flood Water – Obtained by subtracting Reference Water from MSW.

MWP: MODIS Water Product (Each pixel is assigned a number to identify as either undecided, water not detected, Reference Water detected, Flood water detected where there is no reference water present)

MODIS Inundation Mapping



National Aeronautics and Space Administration



NRT Global MODIS Flood Mapping

- Home
- Algorithm
- Product Description
- Data Download**
- Multimedia
- Future Upgrades & Enhancements
- News/Status

3 Day Composite2 Day Composite1 Day Composite14 Day Composite

« December 2013 »

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Products		Available Downloads	
MODIS Flood Map	MFM	png	
MODIS Flood Water	MFW	shapefile (.zip)	KMZ
MODIS Surface Water	MSW	shapefile (.zip)	KMZ
MODIS Water Product	MWP	geotiff	
README		pdf	txt

Check slide show for the last 10 days.

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Archive
Available

Composite
Map

10-day
Sequencing

png, kmz,
geotiff images
available

Importing MODIS Surface Water Data in GIS

Dartmouth Flood Observatory

Dartmouth Flood Observatory

<http://floodobservatory.colorado.edu/>

[Home](#)

[Active
Archive of
Large
Floods,
1985-Present](#)

- [Global
and
Regional
Analyses](#)

[Master Index
of
Inundation
Maps](#)

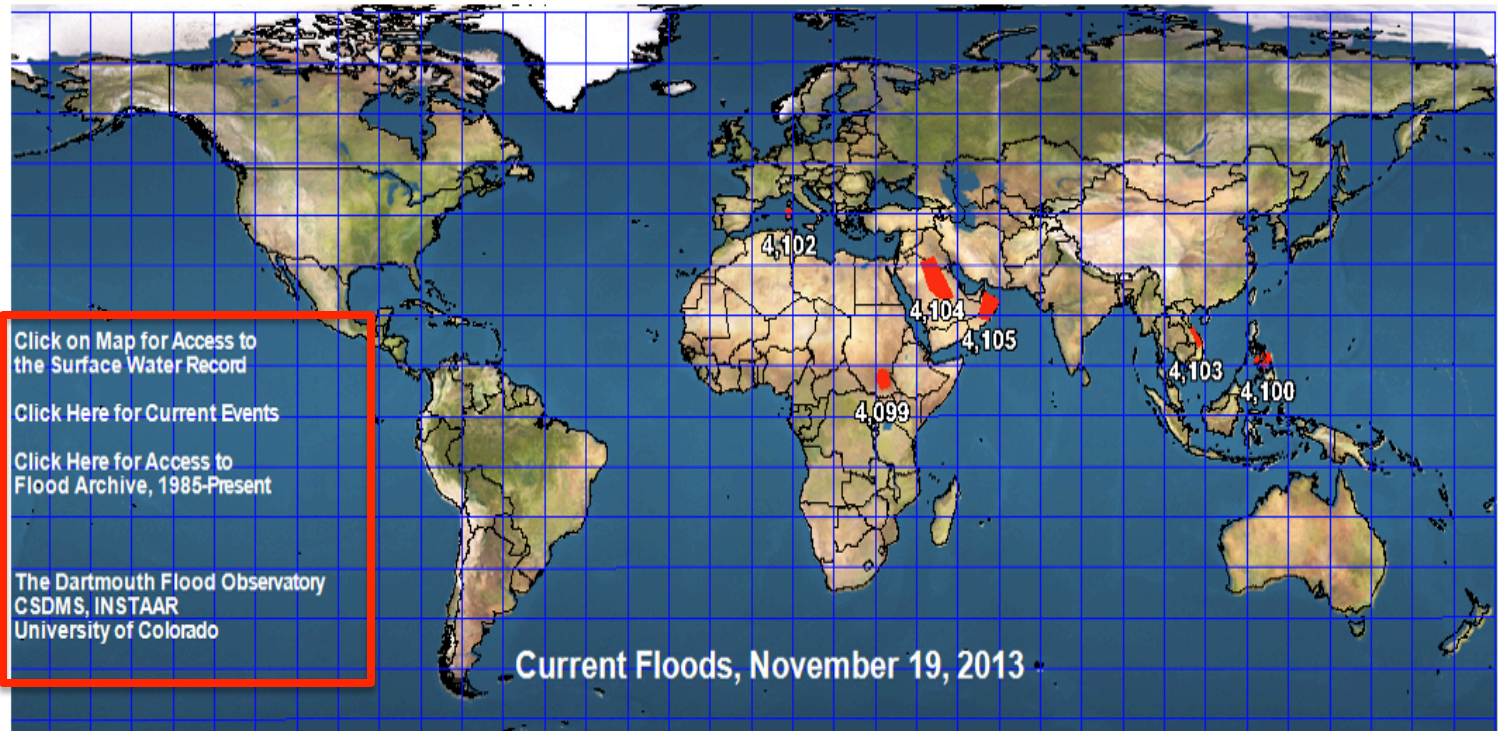
[The Surface
Water
Record](#)

[River Watch](#)

[Other Flood
Detection
Tools](#)

[Sample
Images and
Maps](#)

Dynamic Surface Water Maps (floods, droughts, lakes and reservoirs, and the coastal zone)

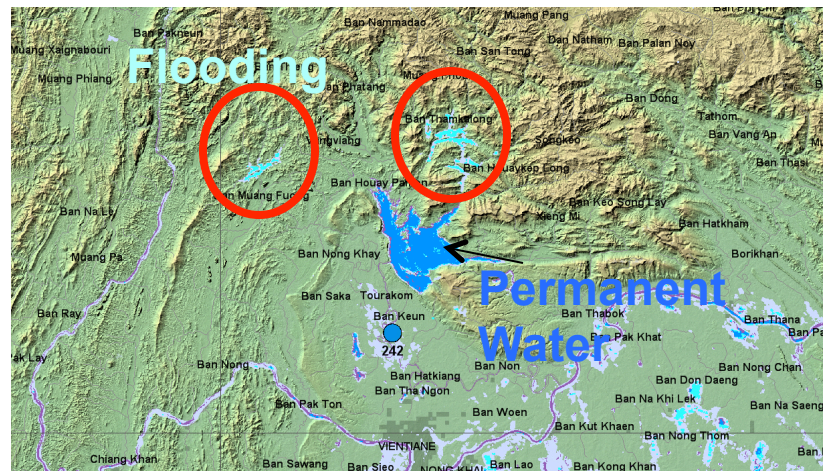
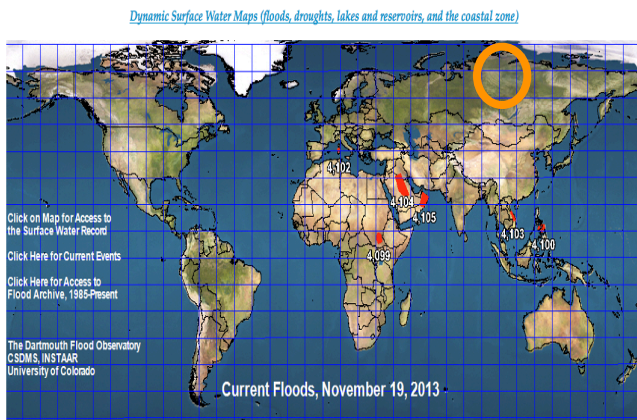


[Access to Experimental Satellite-based River Discharge Measurements](#)

Dartmouth Flood Observatory MODIS-based Flooding

<http://floodobservatory.colorado.edu/>

These maps provide ***current surface water extent*** based on NASA MODIS data, and the observed ***recent history of changes*** (2000 to present). Surface water expansions and contractions are both recorded. Mapped water expansions may be short-term, from inland flooding or coastal storm surges. Or long-term, from post-2000 construction of new reservoirs or increases in rice agriculture or aquaculture.



Map Legend

At the time of map date:

Large areas of purple are dry land (formerly water in February, 2000, when the reference SWBD water database was obtained). At higher latitudes, such areas may be ice-covered water.

Small areas of purple are water mapped by SWBD, but are too small to be mappable by MODIS.

Dark blue is current water, imaged by MODIS and by SWBD in 2000 ("permanent" water).

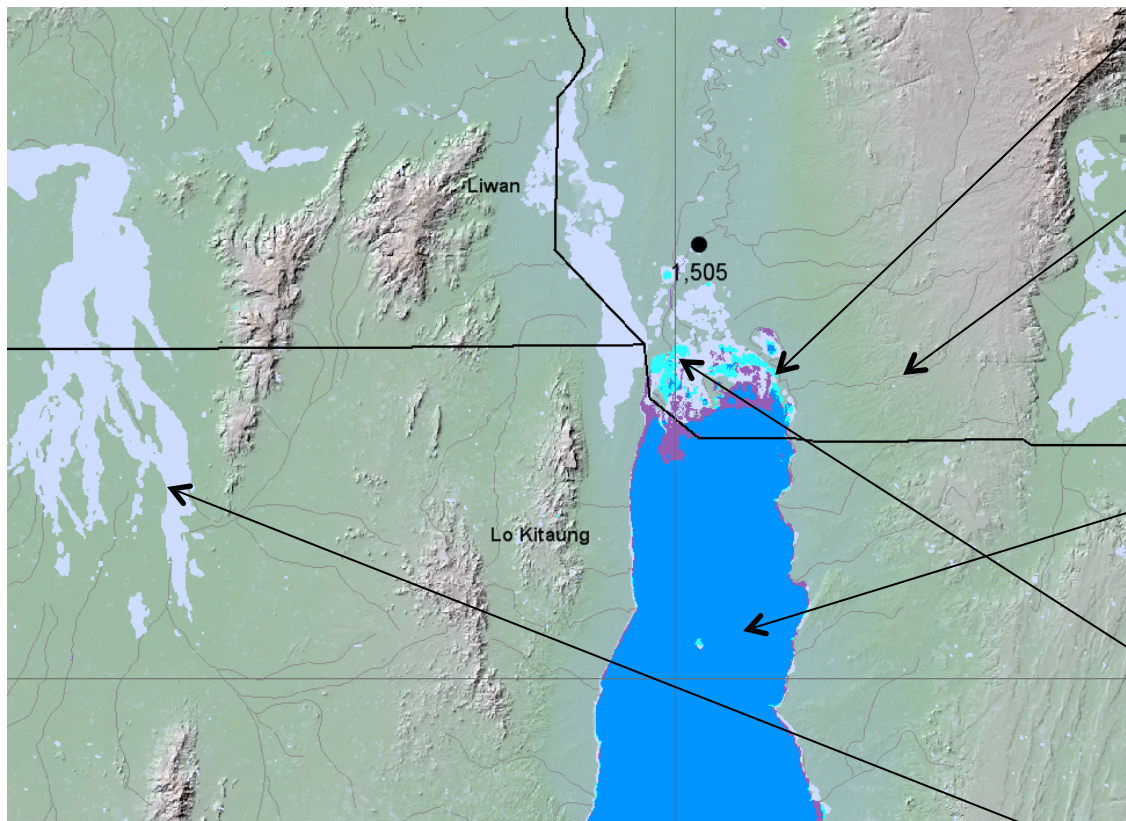
Bright blue is flooding: expanded water areas mapped by MODIS compared to SWBD. **Any post-2000 reservoir or new water body** is also depicted in bright blue.

Light blue-gray is all previous flooding imaged and mapped by the Flood Observatory (now dry land). Note: in mountainous areas, local shadows are commonly mis-classified as water. See also the [Record Guide](#).

- Shuttle Radar Topography Mission Water Body Data (SWBD) ~ 30 m resolution

Dartmouth Flood Observatory MODIS-based Flooding

<http://floodobservatory.colorado.edu/>



Large Area of Dark Purple : Dry Land but formerly water in 2000

Small Area of Purple : Water from Shuttle Radar Topography Mission Water Body Data (SWBD) ~ 30 m resolution

Dark Blue : Current Water from MODIS and SWBD in 2000

Bright Blue : Flooding mapped by MODIS

Light Blue-Grey: Previous Flooding but now dry land

Experimental Flood Mapping based on Passive Microwave Brightness Temperatures

Dartmouth Flood Observatory: MODIS Flood Mapping

<http://floodobservatory.colorado.edu/>

River Watch Project provides river discharge based on passive microwave remote sensing – TRMM/TMI and AMSR and AMSR-2 37 Ghz Brightness temperatures used together with global run off model



140E010S Surface Water Record

This display shows areas of expanded surface water during recent flooding. It also provides the observed history of flooding, commencing in the year 2000. See the [Drought Display](#) for areas of reduced surface water.

Red is most recent flooding mapped. Water areas are accumulated over 10 days to remove obscuration by cloud cover. See also [NRT Global MODIS Flood Mapping](#) for today's two-day composite, including areas of cloud cover. Very recent flooding (past several days) may not appear on this map if cloud cover is heavy.

Light red is previous flooding in the current year.

Light blue is previous flooding since January, 2000.

Dark blue is the reference water (February, 2000, from the [Shuttle Radar Topography Mission Water Body data](#)).

During flood events, and as the extent of lakes, reservoirs, and rivers expand, red areas appear and increase in size. As flooding wanes and floodplains dry, red transitions to light red and then (in the new year) to light blue.

Error notes: 1) In mountainous regions, terrain shadows mimic surface water and are mis-classified as water in our current algorithm. We are working to reduce such noise. 2) Reservoirs and impoundments constructed since yr 2000 appear permanently in red. 3) The observational record illustrated may not include all floods: prior to 2011 the records were obtained manually and focus was on major flood events.

Other information: See also the [FAQ](#). Any clickable black dots on these displays link to the [River Watch](#) satellite discharge measurement sites. The shaded relief background is from topography provided by NASA SRTM data. Recent GIS data (daily surface water information, as .shp file water boundaries) from the automated MODIS-LANCE NRT Flood processor are located (find appropriate 10 degree folder) at http://csgdms.colorado.edu/pub/flood_observatory/MODISlance/. GIS data (MapInfo format) of the long term record of flooding are also available: [at this location](#). Finally, see the [technical description](#), and the time series of annual flooding via a [powerpoint slide file](#).

Dartmouth Flood Observatory: River Discharge Data

<http://floodobservatory.colorado.edu/>

TRMM Microwave Imager and Advanced Microwave Scanning Radiometer measurements are sensitive to the proportion of water and dry land

microwave signal are converted to actual river discharge (similar to streamflow, cubic meter of water flowing per second) by combining them with surface discharge measurements and then to runoff (water flow from land to a water body) by using a Water

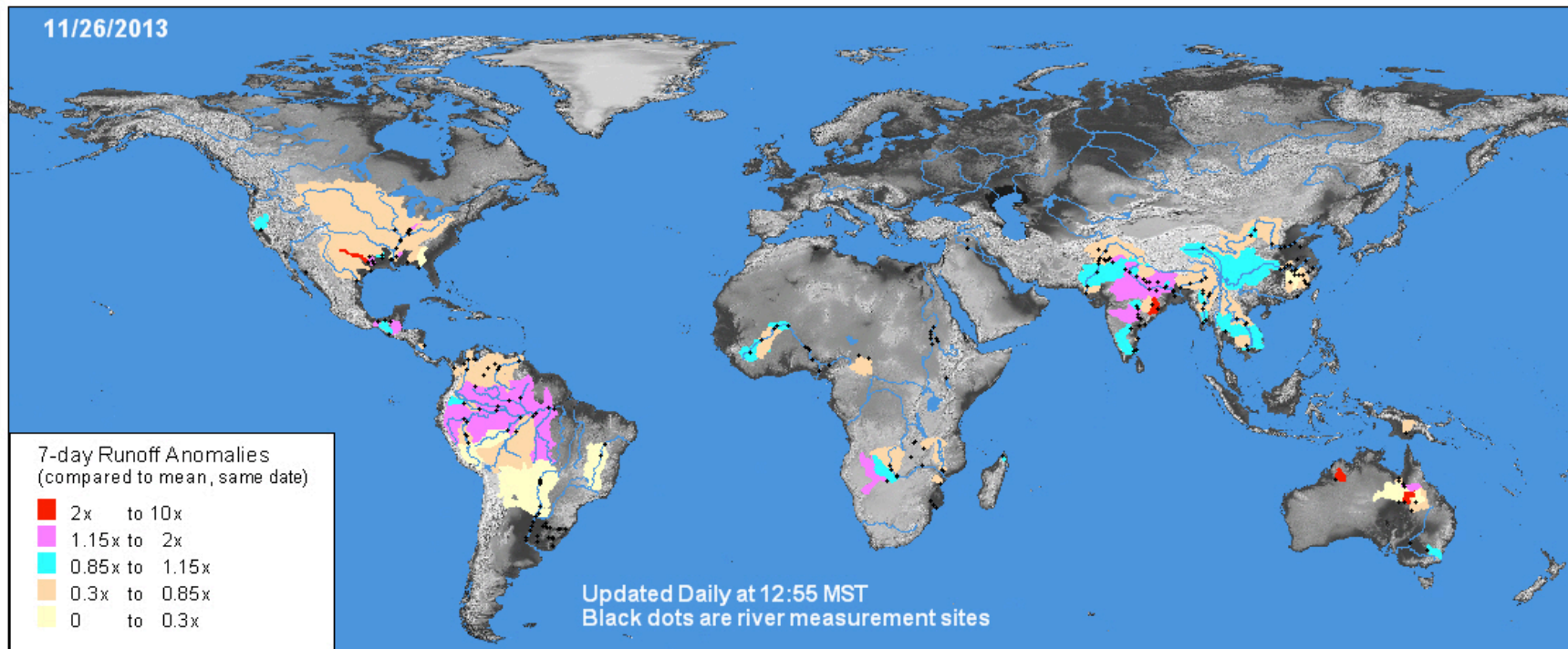
Balance Model (WBM) Runoff calculations are available since 2003. Seven-day runoff deviation from 2003-2007 mean runoff is mapped to indicate low, normal, moderate flooding, and major flooding

Dartmouth Flood Observatory: River Discharge Data

<http://floodobservatory.colorado.edu/>

From Water Balance Model and TRMM/TMI Brightness Temperatures

Surface Water Runoff Measurements from the [River Watch processor](#) (Brakenridge, G. R., De Groeve, T., Cohen, S., and Nghiem, S.V., online publication, this location)



[Large Format Version](#)

River Run-off anomalies show where flooding may be occurring

River Discharge is the water flow in m^3/sec

Summary

- MODIS provides high-resolution inundation mapping capability in the absence of clouds
- MODIS Near-real time flood monitoring tool provides daily inundation maps as well as archived inundation maps since 2010
- The Flood Observatory uses the MODIS inundation tool at 14-day composite window to remove cloud obscuration – near-real time maps are available. Also provides additional surface water indications (drier or wetter) with respect to past observations
- The Flood Observatory provides experimental river watch (discharge estimates) derived from combined Microwave Imager data and a run-off model – current 7-day flooding conditions over selected river basins are available
- MODIS-based surface water data can be accessed in GIS